Alpha: The Interactive Robot

Neelotpal Dutta (B16106) *, Prashant S Gupta (B16025)†,Navneet Sharma (B16065) ‡,
Shikhar Shashya (B16114) §,Sarthak Shekhawat (B16033)¶,Amirth Varshan(B16089) ‖

{* b16106, † b16025, ‡ b16065, § b16114, ¶ b16033, ‖ b16089}@students.iitmandi.ac.in

***Abstract*—The objective of the project is to design a multi-purpose voice-controlled interactive robot. It can interact with the user by speaking out its replies. It can move around and pick up objects. It is also a mode of entertainment, learning and information. When bored, the user can talk with it and also play music. It has a game which can teach children to read. Thus, another objective is to display the versitility of such robots.The result of the project is the robot Alpha which fulfils the objectives.**

I. Introduction

In the recent years, the topic of human-robot interaction has drawn a lot of attention [1]. As the use of robots are increasing, their numbers around us is also increasing . So the interaction between the robots and human has become very important. One of the best ways to interact would be voice. A robot that can listen and speak would make it easier to be used. Further, this feature makes a robot more human-like companion. Such robots are already used in areas likes Autism therapy [1].

The objective of the project is to build the prototype of a versatile robot with special emphasis on speech recognition and synthesis. The result is the robot- Alpha. The robot is based on Arduino Mega 2560 micro-controller board. In the later sections the construction and working of the robot is explained.

TABLE I
Apparatus used

Apparatus	Quantity
Arduino Mega 2560	1
Arduino Uno	1
HC-05 Bluetooth module	1
DHT-11 sensor	1
LM386 amplifier	1
9g Servo motors	2
500rpm DC motors	2
4 ohm Speaker	1
L293D motor driver	1
bread board	3
9 volt DC supply	1
16x2 LCD Display	1
Resistors	10
Capacitors	5
Potentiometer	1

II. Description of the components used

- **Arduino Mega [2] :** It is a microcontroller board based on ATmega1280. It has 54 digital input/output pins and 16 analog inputs. In the project, it is used as the main controller.
- **Arduino Uno [3] :** It is also a micro-controller board based on ATmega328P. It has 14 digital input/output pins and 6 analog input pins. It is used to control speech production.
- **Bluetooth Module(HC-05) [4] :** The bluetooth module is used to connect the Mega micro-controller to the phone through which input is gathered.
- **Temperature and Humidity sensor(DHT11) [5] :** The DHT 11 is a temperature and humidity sensor. To calculate humidity, the resistance between two electrodes with a moisture holding material between them is considered. As the moisture content changes, the resistance also changes. To measure the temperature, it uses a thermistor. The device works for the temperature range of 0-50° Celsius with 2° Celsius of accuracy. It senses humidity in the range of 20% to 80%. The sampling rate is 1 kHz.
- **DC motors and Motor driver(L293D) [6] :** The micro-controller sends signals to the DC motors(500 rpm) via a L293D motor driver to provide the necessary power to the motors.
- **Servo motors:** The servo motors are used in the arm. These motors work with pulse width modulation [7]. The angle of the shaft of the motors is contorlled.
- **LM386 audio amplifier [8] :** The output of the Uno board is not strong enough to be able to feed to the speaker. So the signal is amplified by using the LM386 amplifier IC with the circuit shown in Fig. 3.
- **LCD [9] :** The prototype includes a 16x2 blue LCD to display the output [10].

Fig. 1. Bluetooth Module [4]

Fig. 2. Temperature and Humidity Sensor [5]

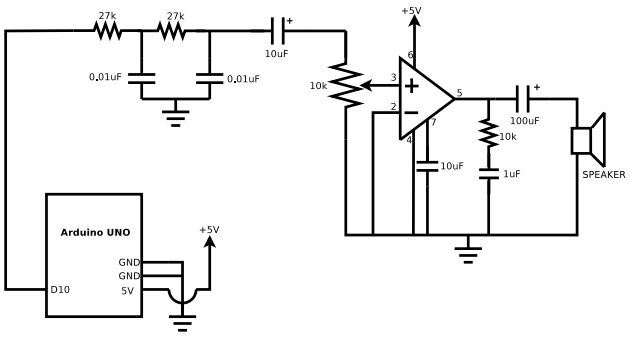

Fig. 3. The circuit for the the amplifier [11]

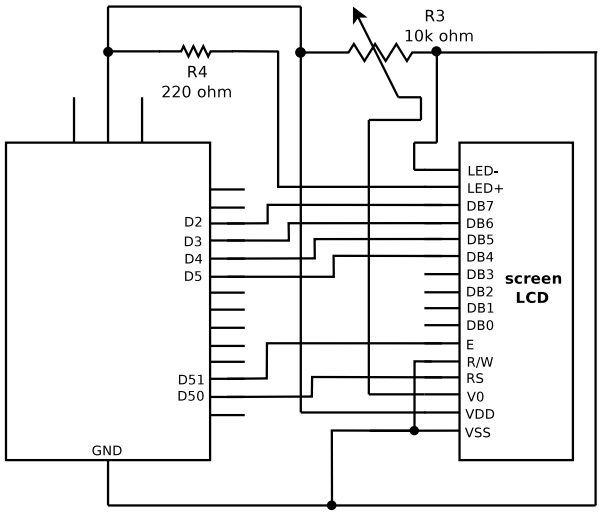

Fig. 4. The circuit for the LCD [10]

III. Design and Working

The main circuit for the robot shown in Fig. 6 and Fig. 7. The structure of the robot is depicted in the images Fig. 9 and Fig. 10. Fig. 5 shows the flowchart for the implementation of the design. The user feeds input using the Alpha Controller app (Subsection IV-D). The app connects to the robot via Bluetooth. The user speaks the command and the app sends the commands as strings to the Arduino Mega which processes the command to take the necessary action. If necessary, it takes in the input from the sensors attached and computes the output. The Mega controller then passes a command to the Uno controller which feeds the signals to the speaker via the amplifier circuit. Thus, the output is produced through the speaker. Furthermore, the Mega board also controls the LCD to display some of the outputs.

The codes are written on the Arduino IDE [12].

The Mega and the Uno micro-controller connection is via I2C connection (Subsection IV-B). The SCL and SDA(refer section IV-B) pins of two boards are connected. The Mega is the master which controls the output of the Uno board. The Uno board is used because the speech synthesis uses the Talkie Library which works only on ATmega168/328 boards like Uno and not on Mega.

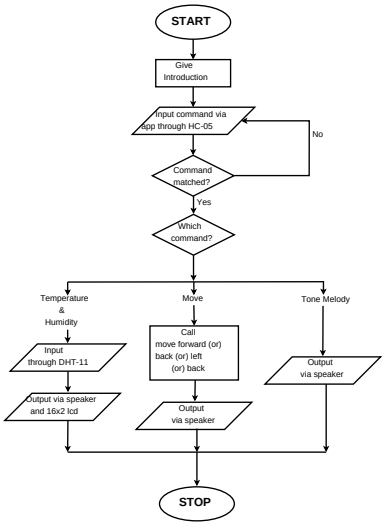

Fig. 5. Flow Chart for the implementation of design

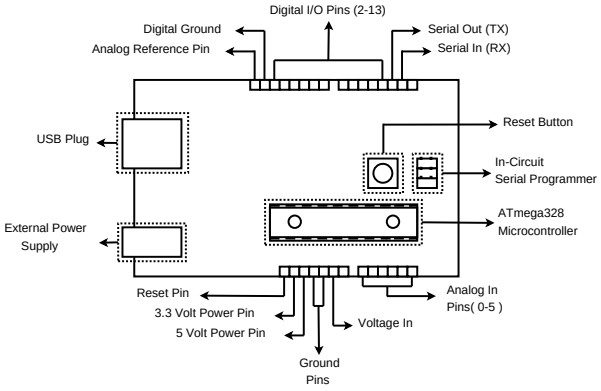

Fig. 6. The connections with the UNO board

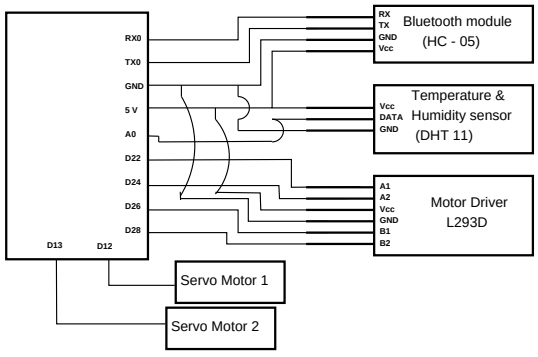

Fig. 7. The Connections for the Mega board

A. The Talkie Library [13]

The Talkie library is a software implementation of the Texas Instruments speech synthesis architecture(Linear

Predictive Coding) [13] . This library has a collection of over 1000 words. This library works with a amplifying circuit and does not use any text-to-speech hardware.

B. I2C Connection [14]

I2C or intra- integrated circuit is a serial computer bus which uses the Serial Data Line(SDL) and Serial Clock Line(SCL) to communicate among the boards. In our project, the UNO is receiving data using this connection.

C. The Spelling Game

This simple game involves the LCD. It displays a word on the LCD. The user should read it out. The robot provides feedback accordingly . It can teach the children to read correctly.

D. The Alpha Controller

The robot takes voice command through a mobile phone. It uses an Android app for this. The app, Alpha Controller (Fig. 8 shows the user-interface of the app) is made using App Inventor for Android provided by Google [15] and maintained by Massachusetts Institute of Technology. The app converts the speech to text using Google API. The strings are then passed on to the Mega board through a bluetooth connection. It also has some control keys to facilitate console control.

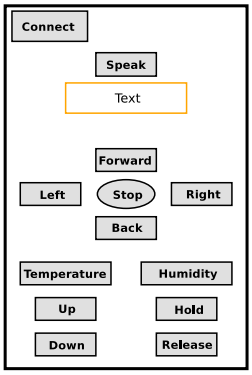

Fig. 8. User-interface of the Alpha Controller

E. Commands and Control:

The following are the some of the commands to control the robot:

TABLE II
COMMANDS

Command	Output
move forward/move/forward	Moves forward and speaks out that it is moving ahead
right	Moves right and speaks out that it is moving right
move back/back	Moves Back and speaks out that it is moving back
left	Moves left and speaks out that it is moving left
up	moves the arm up
down	moves the arm down
hold	holds the object
release	releases the object
remember path/path	starts remembering its path until it is asked to return
return	returns along the remembered path
what is the temperature/temperature	speaks out the temperature and also displays it on the LCD
what is the humidity/humidity	speaks out the humidity and also displays it on the LCD
sum followed by the two integers (positive only)	displays and speaks out their sum
play music	plays music
set alarm followed by the time	sets alarm
teach	opens the spelling game
any common question used in normal conversation like hi, what is your name and so on	replies to the question

IV. RESULTS

The result is the prototype of a robot which can do the following tasks:

- Move Around
- Pick up objects
- Tell temperature and humidity
- Do simple mathematical operations
- Play music
- Train to read
- Set alarm
- Talk with user
- Remember path

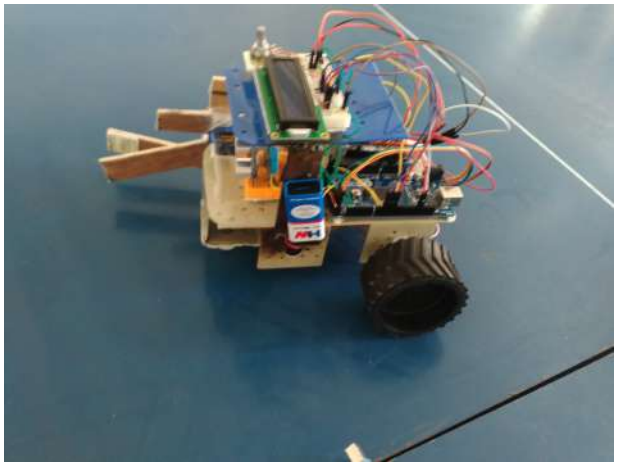

Fig. 9. Alpha

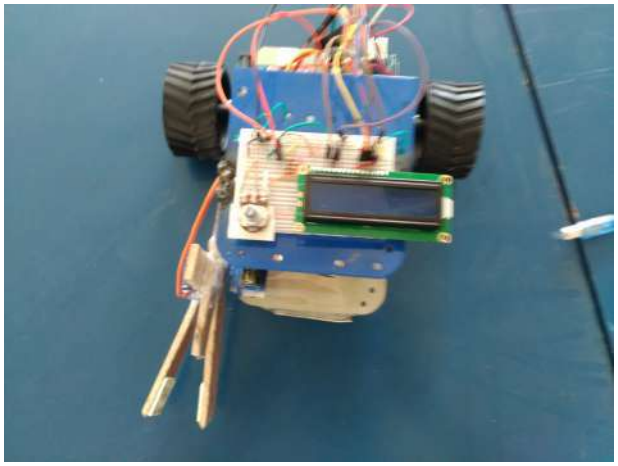

Fig. 10. Alpha

V. Conclusions

We proposed to build a versatile robot that can interact through speech. The results show that the objective was completed.

The project was a great learning experience. We were able to build a prototype which can demonstrate the versatility of tasks such a robot can conduct.

Most of the actions were hard-coded in it. But an interesting future task might involve introduction of the techniques of machine learning to it, which would make it more useful and autonomous . Further, a better controller like Raspberry pi could be used.

References

[1] D. Kerstin, "Human Robot Interaction," accessed on 19.04.2017. [Online]. Available: https://www.interactiondesign.org/literature/book/the-encyclopedia-of-human-computer-interaction-2nd-ed/human-robotinteraction

[2] "Datasheet-Arduino Mega 2560," accessed on 29.04.2017. [Online]. Available: http://www.mantech.co.za/datasheets/products/A000047.pdf

[3] "Datasheet-Arduino Uno," accessed on 19.04.2017. [Online]. Available: https://www.farnell.com/datasheets/1682209.pdf

[4] "Datasheet-HC-05," accessed on 29.04.2017. [Online]. Available: http://www.electronicaestudio.com/docs/istd016A.pdf

[5] "Datasheet-DHT11," accessed on 19.04.2017. [Online]. Available: https://akizukidenshi.com/download/ds/aosong/DHT11.pdf

[6] "Datasheet-LM386," accessed on 29.04.2017. [Online]. Available: http://www.ti.com/lit/ds/symlink/l293.pdf

[7] Cornelam, "Arduino Servo Motors," accessed on 19.04.2017. [Online]. Available: http://www.instructables.com/id/Arduino-Servo-Motors/

[8] "Datasheet-LM386," accessed on 29.04.2017. [Online]. Available: http://www.ti.com/lit/ds/symlink/lm386.pdf

[9] "Datasheet-16x2 LCD," accessed on 29.04.2017. [Online]. Available: https://www.sparkfun.com/datasheets/LCD/ADM1602KNSW-FBS-3.3v.pdf

[10] A. David, F. Limor, and T. Igoe, "LiquidCrystalDisplay," 2010, accessed on 29.04.2017. [Online]. Available: https://www.arduino.cc/en/Tutorial/LiquidCrystalDisplay

[11] Contributor, "Text-to-speech-on-arduino," accessed on 29.04.2017. [Online]. Available: blog.circuits4you.com/2016/04/text-to-speech-onarduino.html

[12] N. Dutta, P. Gupta, N. Sharma, A. Varshan, and S. Shekhawat, "Alpha Codes." [Online]. Available: https://drive.google.com/drive/folders/0B85lXXt8hl21d0I0OWc4d0E0akE?usp=sharing

[13] going-digital (contributor), "Talkie-Library," 2016, accessed on 25.04.2017. [Online]. Available: github.com/going-digital/Talkie

[14] SFUPTOWNMAKER, "I2C," accessed on 03.04.2017. [Online]. Available: https://learn.sparkfun.com/tutorials/i2c

[15] MIT, "MIT App Inventor," accessed on 03.05.2017. [Online]. Available: http://appinventor.mit.edu/explore/